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(54) **AIRBORNE SATELLITE COMMUNICATIONS SYSTEM**

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H01Q 1/32 (2006.01)

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CPC . ***H01Q 1/125*** (2013.01); *H01Q 1/32* (2013.01)

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CPC H01Q 1/125; H01Q 3/04; H01Q 3/08; H01Q 1/1257
USPC 342/357.21, 357.4, 357.63, 359; 343/754, 757
See application file for complete search history.

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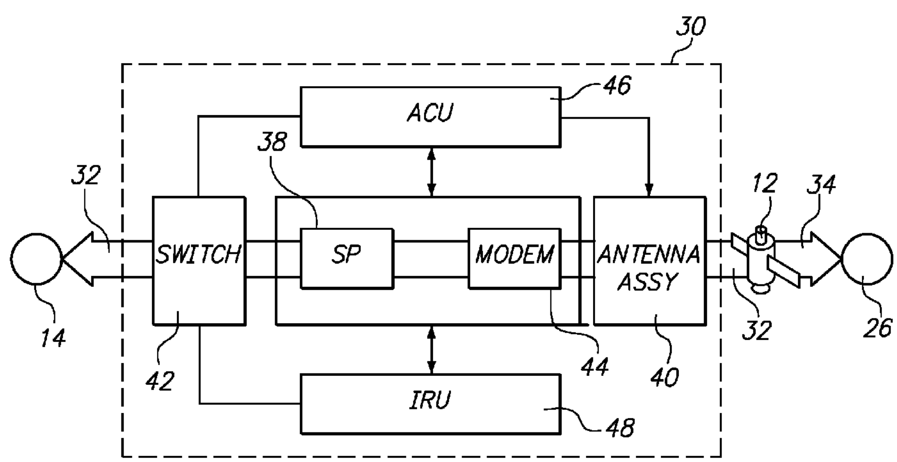
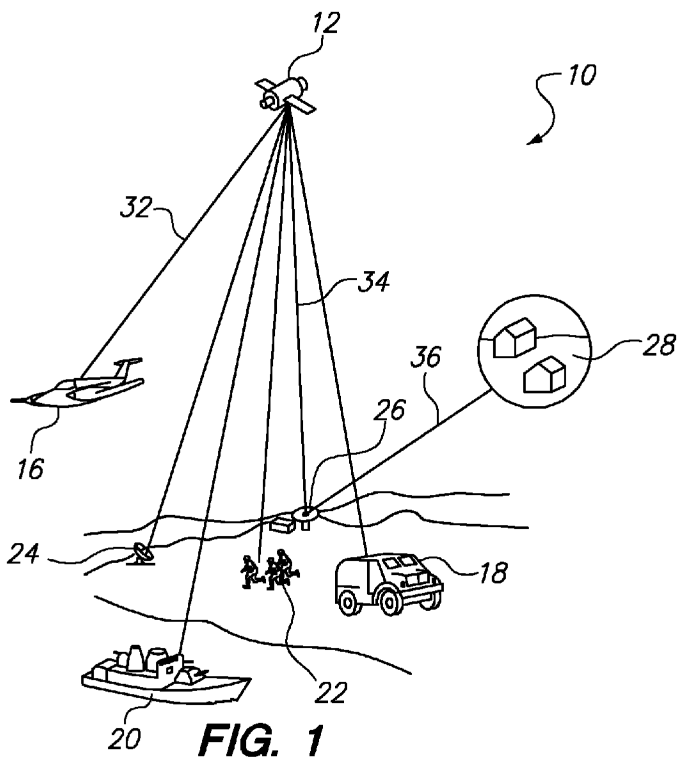
(57) **ABSTRACT**

A system is provided to establish and maintain a data path between a Local Area Network (LAN) that is mounted on a moving vehicle and a satellite. In combination, an antenna assembly, an Antenna Control Unit (ACU), an Inertial reference Unit (IRU), and a modem are mounted together on the moving vehicle, under the overall control of a services platform. Operationally, the IRU generates parametric values indicative of the spatial attitude and location of the moving vehicle. The ACU then uses the parametric values to aim the antenna in a direction toward the satellite. In this combination, the modem is connected with the antenna to transmit and receive data between the system and the satellite. Individually or collectively, operationally compatible components of the system (IRU, ACU, antenna and modem) can be appropriately substituted to thereby customize the system.

20 Claims, 1 Drawing Sheet




12
10
32
34
36
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16
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22
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FIG. 1

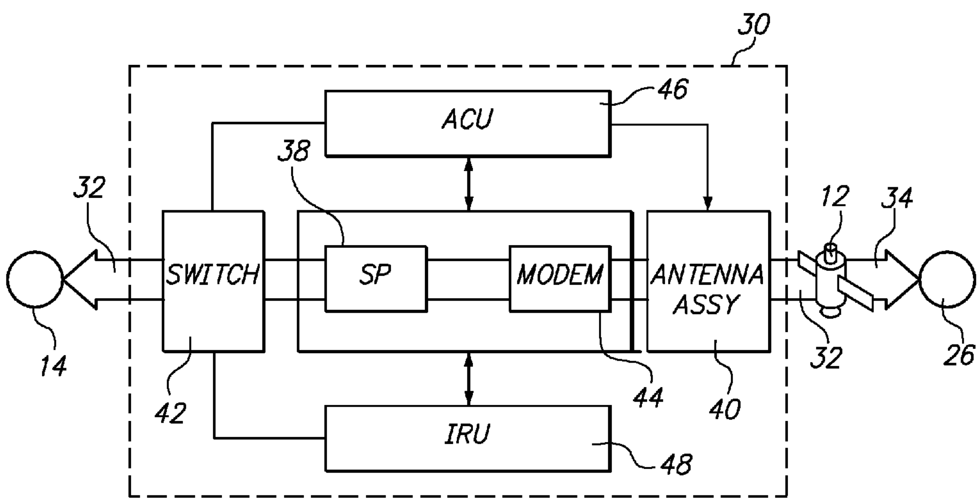
30
ACU
46
38
32
12
34
SWITCH
SP
MODEM
ANTENNA ASSY
14
42
44
40
32
26
IRU
48

FIG. 2

AIRBORNE SATELLITE COMMUNICATIONS SYSTEM

FIELD OF THE INVENTION

The present invention pertains generally to satellite communications systems. More particularly, the present invention pertains to satellite communications systems wherein a Local Area Network (LAN) is mounted on a moving vehicle. The present invention is particularly, but not exclusively, useful in a satellite communications system wherein the combination of components for communication and antenna control can be customized for operational compatibility, to thereby establish and maintain a data path between the moving vehicle and the satellite.

BACKGROUND OF THE INVENTION

Satellite communications systems rely on the ability of a LAN to establish and maintain a data path between the station and the satellite. Not surprisingly, this is no easy task. Moreover, the ability to operationally maintain the data path becomes increasingly complex when the LAN is mounted on a moving vehicle. Accordingly, the operational control of an antenna assembly that is suitable for use with the moving vehicle is a very important design consideration.

As a practical matter, there are many different types of moving vehicles (i.e. airborne, terrestrial and maritime), and they will each have their own respectively unique and different operational requirements. A consequence of these differences is that different types of antenna assemblies are typically required. Further, as implied above, each antenna assembly will necessarily have its own control requirements. On top of this, operational flexibility may require the ability to change the configuration of a particular LAN and/or its antenna assembly. More specifically, there are situations wherein it may be desirable to replace one antenna assembly with another type antenna assembly. In such a case, as well as in other cases wherein moving vehicles have unique but changed requirements, the ability to substitute one antenna assembly for another may be desirable. In the event, system component compatibility and interoperability must be established.

In light of the above, it is an object of the present invention to provide a customized satellite communications system with the capability of individually or collectively substituting operationally essential components, such as an antenna assembly, without compromising the system's operational compatibility. Still another object of the present invention is to provide a satellite communications system that can establish and maintain a data path between a satellite and a moving vehicle. Yet another object of the present invention is to provide a satellite communications system with a flexible methodology for changing operationally compatible components that is easy to perform in a cost effective manner.

SUMMARY OF THE INVENTION

In accordance with the present invention, a system is provided for use in connecting a LAN into a satellite communications network. Specifically, the system is provided to establish a central management interface between the electronic components that interchange operational data. In particular, this interchange of data is accomplished by the system to control the components that establish and maintain a data path between the LAN and a satellite. As envisioned for the present invention the system will be mounted on a moving vehicle that may either be airborne, terrestrial or maritime.

Components for the system of the present invention include a services platform, an antenna assembly, an Antenna Control Unit (ACU), an Inertial Reference Unit (IRU) and a modem. For communication purposes, the antenna assembly is connected to the modem, and the modem is connected with the services platform. In turn, the services platform is connected to the LAN. Thus, the LAN is connected in communication with the antenna assembly. On the other hand, for control purposes, the antenna assembly is connected with the ACU, and the ACU is connected via the services platform with the IRU. Thus, the antenna assembly is operationally controlled by the ACU to establish and maintain a communication data path between the LAN and a satellite.

For operational control of the antenna assembly, the IRU generates parametric values that are transferred by the services platform for input to the ACU. More specifically, these parametric values are indicative of both a spatial attitude of the moving vehicle (e.g. pitch, roll and yaw), and a location of the moving vehicle (e.g. position, altitude and velocity). Typically, the location information can be provided by a GPS capability. In the event of a GPS failure, however, the system of the present invention can revert to inertial sensing techniques for its location information.

In operation, under control from the services platform, the ACU converts input from the IRU into antenna orientation parameters. More specifically, based on inputs from the IRU, the antenna assembly is dynamically oriented by the ACU in response to movements of the vehicle. Thus, movements of the antenna assembly are controlled with appropriate elevation, azimuth and polarization inputs to establish a data path between the antenna and the satellite. At the same time, also under control from the services platform, system signals will be converted between Ku-band (used on the data path between the moving vehicle and the satellite) and L-band (between the LAN and the modem and between the modem and the antenna). Further, the services platform and modem encode/decode and assemble/disassemble data. The services platform will also direct data transmissions in the LAN.

BRIEF DESCRIPTION OF THE DRAWINGS

The novel features of this invention, as well as the invention itself, both as to its structure and its operation, will be best understood from the accompanying drawings, taken in conjunction with the accompanying description, in which similar reference characters refer to similar parts, and in which:

FIG. **1** depicts an operational environment for the present invention; and

FIG. **2** is a schematic layout of the components that are used by the present invention to establish and maintain a data path between a moving vehicle and a satellite.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring initially to FIG. **1** an environment for implementing the present invention is shown and is generally designated **10**. As shown, a satellite **12** is used to establish a communication link with a Local Area Network (LAN) **14** [see FIG. **2**] which can be variously located on a moving vehicle in the environment **10**. For instance, a LAN **14** can be carried on an airborne vehicle **16**, a terrestrial vehicle **18** or a maritime vehicle **20**. As envisioned for the present invention, the airborne vehicle **16** may be an airplane (as shown), or it may be a rocket, a balloon, a helicopter or a pilotless drone.

Further, the terrestrial vehicle **18** may be a truck (as shown), or it may be any other form of land transportation. Additionally, the maritime vehicle **20** may be a ship (as shown), or any other form of seaborne transportation. Also, a LAN **14** may be carried by personnel **22** or connected with a mobile base **24**. In each case there will be a communication link between a respective LAN **14** and the satellite **12**. There will also be extended communication between the satellite **12** and a ground-based central hub **26**. From there, another communication link is established between the central hub **26** and a central facility **28**. As envisioned for the present invention, overall control of the components that interconnect the LAN **14** with the satellite **12** is provided by a system **30** (see FIG. **2**).

For purposes of this disclosure, consider the moving vehicle to be the airborne vehicle **16**, and that it is in communication with the central facility **28**. As shown in FIG. **1**, this essentially requires three communication links. First, there is a data path **32** from the airborne (moving) vehicle **16** to the satellite **12**. Next, there is a data path **34** from the satellite **12** to the hub **26**. And finally, there will be a data path **36** from the hub **26** to the central facility **28**. In this context, the data path **34** can be established in any of several ways known in the pertinent art, and the data path **36** can be established using known technology. Of specific interest for the present invention, however, is the data path **32**.

With reference to FIG. **2** it will be appreciated that the data path **32** is to be controlled and maintained by connections in the system **30** that are established and controlled by a services platform **38**. In accordance with the present invention, the operational control provided by the system **30** is functionally two-fold. On the one hand, there is the orientation control of an antenna assembly **40**. On the other, there is the communication control of a switch **42**. Overall control of both is effectively provided by the services platform **38**.

For the communication functions of the present invention, consider the data path **32** that extends between the satellite **12** and the LAN **14**. Keep in mind, this will be a two-way communications data path **32** for both transmit and receive by the LAN **14**. Between the satellite **12** and the system **30**, the data that is carried on the data path **32** will be carried on Ku-band. Data that is received by the antenna assembly **40** will be passed to a system **30** where it is converted from Ku-band to L-band. In concert with the services platform **38**, the modem **44** will then also be used to encode/decode and assemble/disassemble the packets of data that are being transmitted on the data path **32**. Further, at the services platform **38**, the communications data on data path **32** is sorted and routed through the switch **42** for further transmission to appropriate stations in the LAN **14**.

For the orientation function of aiming the antenna assembly **40** toward the satellite **12**, the system **30** of the present invention incorporates an Antenna Control Unit (ACU) **46** and an Inertial Reference Unit (IRU) **48**. As shown, the ACU **46** is connected to the antenna assembly **40**, and it is controlled by the services platform **38**, for the purpose of moving the antenna assembly **40** to maintain the data path **32** between the system **30** and the satellite **12**. As also shown, the IRU **48** is controlled by the services platform **38** to generate inputs of parametric values to the ACU **46** which are indicative of a spatial attitude of the vehicle **16**, and its location. In particular, the parametric values for measuring the spatial attitude of the moving airborne vehicle **16** include measurements of pitch, roll and yaw. On the other hand, parametric values for identifying the location of the moving vehicle **16** include position, altitude and velocity. Preferably, the parametric values for the location of the moving vehicle **16** are obtained by selectively using GPS or inertial sensing techniques. Based on these inputs the antenna assembly **40** is dynamically oriented with elevation, azimuth and polarization inputs from the ACU **46**.

While the particular Airborne Satellite Communications System as herein shown and disclosed in detail is fully capable of obtaining the objects and providing the advantages herein before stated, it is to be understood that it is merely illustrative of the presently preferred embodiments of the invention and that no limitations are intended to the details of construction or design herein shown other than as described in the appended claims.

What is claimed is:

1. A system for use in a communications network to establish and maintain a data path between a moving vehicle and a satellite which comprises:

a Local Area Network (LAN) mounted on the moving vehicle;

an antenna assembly mounted on the moving vehicle for connecting the LAN in communication with the satellite via the data path, wherein the antenna assembly is selected from a plurality of different types of antenna assemblies;

a services platform supported on the moving vehicle for central management of data transfer in the system;

a modem connected with the services platform between the LAN and the antenna assembly to convert signals between Ku-band and L-band and to encode/decode and assemble/disassemble data for data transmissions in the LAN; and

a control unit positioned on the moving vehicle and connected via the services platform with the selected antenna assembly to functionally maintain the data path by dynamically orienting the antenna assembly in response to movements of the vehicle, wherein the control unit is selectively configured for operational compatibility with the antenna assembly.

2. A system as recited in claim **1** wherein the control unit comprises:

an Antenna Control Unit (ACU) connected to the antenna assembly for moving the antenna assembly to maintain the data path;

an Inertial Reference Unit (IRU) connected to the ACU via the services platform for generating an input of parametric values to the ACU, wherein the parametric values are indicative of a spatial attitude of the vehicle and a location of the vehicle; and

a modem connected between the LAN and the antenna assembly for providing data transfer capabilities on the data path.

3. A system as recited in claim **2** wherein the parametric values for the spatial attitude of the moving vehicle include measurements of pitch, roll and yaw.

4. A system as recited in claim **2** wherein the parametric values for the location of the moving vehicle include position, altitude and velocity.

5. A system as recited in claim **4** wherein the parametric values for the location of the moving vehicle are obtained by selectively using GPS and inertial sensing techniques.

6. A system as recited in claim **1** wherein the moving vehicle is selected from a group comprising an airborne vehicle, a terrestrial vehicle and a maritime vehicle.

7. A system as recited in claim **6** wherein the airborne vehicle is selected from a group comprising an aircraft, a rocket, a helicopter, an unmanned aerial vehicle and a balloon.

8. A system as recited in claim 1 wherein the antenna assembly is dynamically oriented with elevation, azimuth and polarization inputs from the control unit.

9. A method for customizing a system for use in a communications network to establish and maintain a data path between a moving vehicle and a satellite which comprises the steps of:

selecting an antenna assembly;

mounting the antenna assembly on the moving vehicle;

supporting a services platform on the moving vehicle for central management of data transfer in the system;

connecting an Antenna Control Unit (ACU) to the services platform and to the selected antenna assembly;

generating parametric values with an Inertial Reference Unit (IRU) for input from the IRU to the ACU via connections on the services platform, wherein the parametric values are indicative of a spatial attitude of the platform and a location of the vehicle;

orienting the antenna assembly with control inputs from the ACU in response to dynamic movements of the vehicle, to enable data transmissions along a data path, wherein the data path establishes communications between a Local Area Network (LAN) on the moving vehicle and the satellite; and

incorporating a modem, wherein the modem is connected with the services platform between the LAN and the antenna assembly to convert signals between Ku-band and L-band and to encode/decode and assemble/disassemble data for data transmissions in the LAN.

10. A method as recited in claim 9 wherein the antenna assembly, the modem, the ACU, and the IRU are respectively selected for mutual operational capability in the system.

11. A method as recited in claim 9 wherein the ACU is selectively configured for operational compatibility with the antenna assembly.

12. A method as recited in claim 9 wherein the parametric values for the spatial attitude of the moving vehicle include measurements of pitch, roll and yaw.

13. A method as recited in claim 9 wherein the parametric values for the location of the moving vehicle include position, altitude and velocity.

14. A method as recited in claim 9 wherein the parametric values for the location of the moving vehicle are obtained using GPS techniques.

15. A method as recited in claim 9 wherein the antenna assembly is dynamically oriented with control inputs from the ACU, and wherein the control inputs include values for elevation, azimuth and polarization.

16. A customized system for use in a communications network to establish and maintain a data path between a moving vehicle and a satellite which comprises:

an antenna assembly;

an Antenna Control Unit (ACU) connected to the antenna assembly for moving the antenna assembly to maintain the data path, wherein the ACU is dedicated to the selected antenna assembly;

an Inertial Reference Unit (IRU) connected to the ACU for generating an input of parametric values to the ACU, wherein the parametric values are indicative of a spatial attitude of the vehicle and a location of the vehicle, and wherein the parametric values are input to the ACU to functionally maintain the data path by dynamically orienting the antenna assembly in response to movements of the vehicle; and

a modem connected between the antenna assembly and a LAN to provide data transfer capabilities on the data path, and to convert signals between Ku-band and L-band and to encode/decode and assemble/disassemble data for data transmissions in the LAN.

17. A system as recited in claim 16 wherein the parametric values for the spatial attitude of the moving vehicle include measurements of pitch, roll and yaw.

18. A system as recited in claim 16 wherein the parametric values for the location of the moving vehicle include position, altitude and velocity.

19. A system as recited in claim 18 wherein the parametric values for the location of the moving vehicle are obtained by selectively using GPS and inertial sensing techniques.

20. A system as recited in claim 16 wherein the antenna assembly is dynamically oriented with elevation, azimuth and polarization inputs from the ACU.

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